

THE MANAGER**MAKING MILK**

By Dr. Thomas R. Overton and David R. Balbian

Can you join the “7 lb club”?

By “7 lb club,” we are referring to those elite dairies that ship more than 7 lbs per day combined of milk fat and true protein per cow. They thus achieve very high levels of net milk income per cow per day compared to their peers. This is a tremendous accomplishment and requires high milk yield and high milk component percentages to reach this level of productivity. As an example, a dairy producing 90 lbs per cow per day, milk fat at 3.7% and milk protein at 3.1% would have 6.1 lbs per cow per day of milk fat and protein shipped. Of course, this is an excellent level of productivity. But we have examples of dairies at or above 100 lbs of milk per cow per day with component percentages at or above those mentioned above, and are near or exceeding 7 lbs of fat and protein per cow per day.

Yields of milk fat and protein are highly correlated with milk yield, but as is evident from the examples above, both high milk yield and high component percentages are required to produce 6 to 7 lbs or more of total fat and protein per cow per day. Milk yield is highly dependent upon excellent management in all facets of the dairy. This includes forage quality, transition cow management, grouping management and cow flow, nutritional management, including both ration formulation and feed management, reproduction, udder health, and calf and heifer management.

Factors affecting milk fat

Many factors affect milk fat percentage and yield on the dairy. These include nutritional and non-nutritional factors. A number of nutritional factors can be involved in situations where milk fat per-

Maximize milk fat and milk protein yields to maximize milk revenue.

centage and yield is lower than typical. Nutritional strategies may help to increase milk fat percentage and yield when milk fat is already within typical ranges on the dairy.

Several non-nutritional factors affect milk fat percentage and yield, including genetics and breed, season, heat stress, and stage of lactation. As is shown in Figure 1, milk fat percentage is typically highest in the late fall and winter before declining in the late winter and spring, reaching its

lowest point in the summer, and then increasing through the fall. Interestingly, this pattern is very similar from year to year, but the overall milk fat percentage can vary markedly from year to year.

Low milk fat percentage, which we will define for the purpose of this article as any time milk fat percentage runs more than 0.3% units below what is typical for the herd or breed, catches the attention of the dairy producer and herd advisors pretty quickly. Certainly, milk fat of 3.5% or less in Holstein herds would qualify in our minds as a low milk fat situation. Classically, low milk fat was thought to be associated with ruminal acidosis and conditions that would also lead to laminitis.

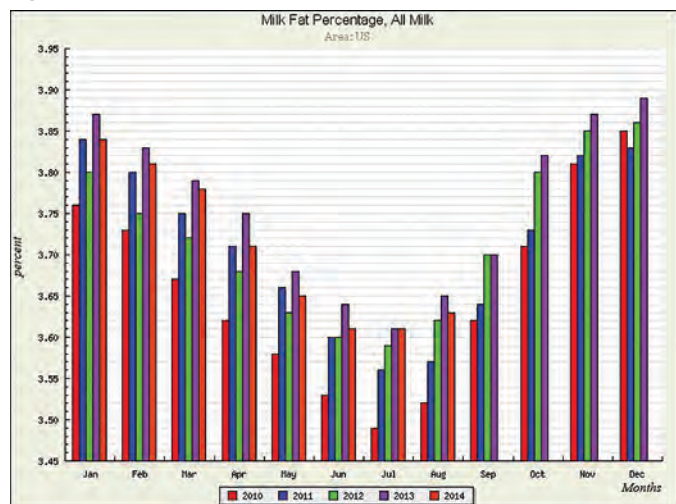
Thanks to research conducted in the 1990s and early 2000s in Dale Bauman's group at Cornell, and continuing to present day in research groups at Penn State, Michigan State, Clemson, and the University of Wisconsin, we now have a much greater understanding of the changes in rumen fermentation and metabolism that lead to low milk fat. Acidosis is only one of the factors that can contribute to low milk fat. In our experience troubleshooting low milk fat issues, the vast majority of herds that have low milk fat appear to be healthy from a rumen acidosis perspective.

To understand how to troubleshoot low milk fat issues, we need to recognize how milk fat is made by the cow. Milk fat is made up of fatty acids and secreted in globules in milk. The fatty acids that make up milk fat come from those made in the mammary gland itself and those that the mammary gland extracts from the blood and incorporates directly into milk fat. These two sources each typically represent about 50% of the fatty acids for milk fat.

In a low milk fat situation, we know that genes responsible for both of these sources of milk fat are inhibited, especially the genes involved in making fatty acids in the mammary gland itself. The culprit for this is actually specific intermediates of fatty acid metabolism in the rumen that are produced when rumen fermentation and metabolism is altered by one or more factors.

Under normal ruminal conditions and metabolism, unsaturated fatty acids that make up the majority of fats in plants are metabolized by the rumen microbes to make them more saturated. This is the reason why cows consume mostly unsaturated fatty acids, yet butter and tallow are considerably more saturated. This metabolism

Figure 1. “Milk Fat Trends”

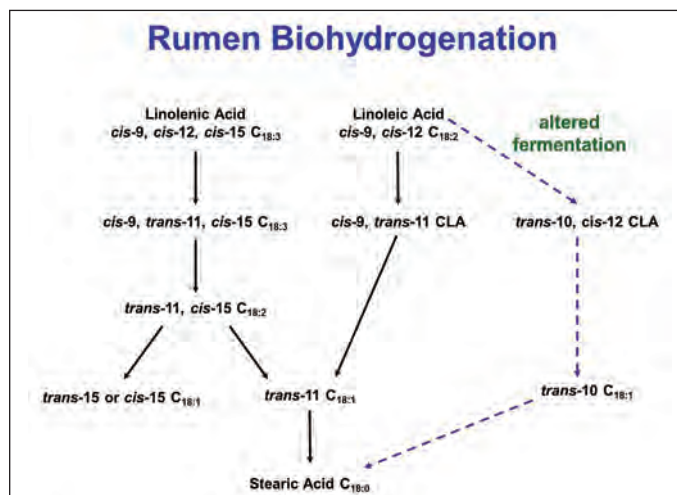


Milk fat percentage by month from 2010 to 2014 across all U.S. milk

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occurs through a series of steps outlined in Figure 2, and although this “biohydrogenation” is extensive, it is not complete, and the intermediate fatty acids can pass from the rumen into the omasum and abomasum for eventual absorption by the intestine.

Figure 2. “Rumen Biohydrogenation”



Low milk fat is caused by altered biohydrogenation of dietary fatty acids in the rumen.

Under conditions that lead to low milk fat, these unsaturated fatty acids are metabolized via alternate pathways, and some of the intermediate fatty acids produced in these alternate pathways are potent inhibitors of milk fat synthesis if they pass from the rumen and are absorbed by the cow. We usually consider four different areas of nutritional risk factors when evaluating a dairy with low milk fat.

First, we evaluate the amount and source of linoleic acid in the diet. As is shown in Figure 2, linoleic acid represents the starting point for rumen biohydrogenation. Linoleic acid makes up about 60% of the fatty acids in corn and in feeds originating from corn (e.g., distillers grains from ethanol) and about 60% of the fatty acids in oilseeds such as soybeans and whole cottonseed. Soybean meal has had most of the fat removed during oil extraction, however, roasted soybeans typically contain about 20% fat.

Although data from a large, commercial farm-based study that we conducted several years ago suggests that some herds can feed very high levels of linoleic acid (500 to 600 grams per day) and maintain high milk fat, our troubleshooting experience suggests that it is worth evaluating the amount and source of linoleic acid any time linoleic acid intakes (as calculated by some ration models) are over 350 grams per day. This may mean decreasing the amount of feeds such as distillers grains or roasted soybeans in the ration, or changing the processing of roasted soybeans to make them more coarse (halves and quarters rather than ground) such that it slows down the speed at which the oil becomes available in the rumen. In a number of cases we have been able to increase milk fat percentage by 0.2 to 0.3% by focusing on the amount and source of linoleic acid in the ration.

Second, we try to assess whether ruminal conditions are present

that result in the altered pathway of rumen biohydrogenation shown in Figure 2, that results in formation of trans-10, cis-12 conjugated linoleic acid. Our short list of nutritional or management factors that contribute to this include factors that promote low rumen pH, mycotoxins, and wild yeasts in corn silage, snaplage, or high moisture corn.

Many factors related to ration formulation, feeding management, and grouping management can result in low rumen pH. These include excessive fermentable carbohydrate relative to fiber, inconsistency in feeding management to include variation in ingredient amounts and mixing that leads to sorting, overstocking pens in excess of 110% of stalls that leads to competition at the feedbunk and slug feeding behavior, and trying to feed early lactation and high cow groups to a slick bunk that also encourages slug feeding behavior. We have been able to counter the effects of mycotoxins, molds, and yeasts in a number of cases by incorporating some of the feed additives that are available to either adsorb or deactivate mycotoxins or acid-based TMR preservatives in the case of yeasts.

Third, we identify whether there are feed or rumen-related conditions that might be slowing down rates of rumen biohydrogenation. This makes it more likely that the fatty acid intermediates will escape the rumen before being further biohydrogenated, thereby amplifying the effects of the risk areas described above. It is important to note that this area of risk only applies when the factors described above are causing low milk fat. They do not decrease milk fat independently. These include excessive intakes of oleic acid (> 200 grams per day), fish fatty acids found in some fat sources and monensin.

Finally, high rates of passage from the rumen contributed to by high milk production and high dry matter intakes, high pasture intake in grazing animals, and fineness of the TMR (> 50% of particles in the bottom pan of the 2-sieve Penn State particle separator) make it more likely that these intermediates can escape the rumen and contribute to low milk fat. In our commercial farm-based study, farms that had more than 54% of TMR particles in the bottom pan had about 0.25% units lower milk fat compared to farms with less than 54% of TMR particles in the bottom pan. High DMI and rates of passage help to explain why high-producing, high-intake herds are more sensitive to nutritional and management-related risk factors than are lower producing, lower intake herds.

The last concept that is important to understand is that the key triggers for low milk fat are going to vary from dairy to dairy. We evaluate all of the above areas and then make a decision in conjunction with the dairy producer and herd advisors relative to which areas are most likely to contribute to low milk fat and what changes we can make in ration or management to try to counteract the culprits. Recent work from Penn State confirms our field observations over time that it takes about 10 to 14 days for milk fat to recover following the correct change in either ration or management.

What about increasing milk fat if my milk fat is “normal”?

When milk fat percentage is within normal ranges for breed and herd, there are a few nutritional options that may result in modest

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increases in milk fat percentage (0.1 to 0.3% units) and yield. Some of these nutritional strategies also exert their effects by increasing overall milk yield. These include rumen buffers, increasing dietary cation-anion difference (DCAD) for lactating cows (as opposed to decreasing DCAD as we commonly do in dry cow rations), yeast and yeast culture that has been selected to improve rumen function, analogs of the amino acid methionine, and fat supplements based upon palmitic acid (> 80% palmitic acid).

Factors affecting milk protein

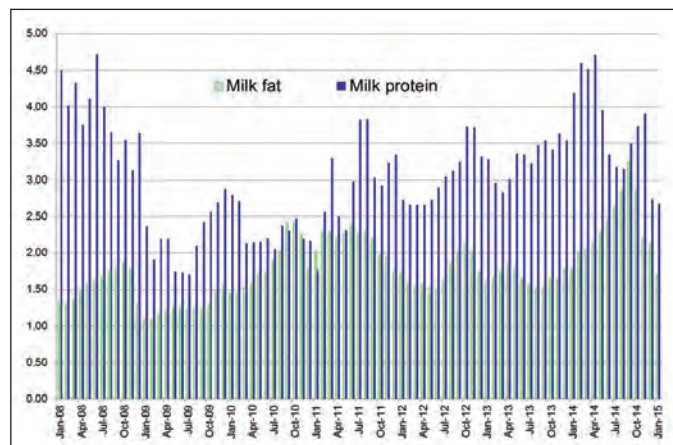
Similar to milk fat, management strategies that increase milk yield also will increase milk protein yield. However, a number of nutritional factors may increase milk protein content and yield. Research conducted during the past several years continues to support the move away from crude protein as a way to evaluate protein supply to the cow and toward metabolizable protein systems in which mathematical models such as the Cornell Net Carbohydrate and Protein System (CNCPS) predict both supply of microbial protein coming from the rumen as well as the supply of rumen-undegradable (bypass) protein. Refinements in this model over time have enabled nutritionists to more tightly balance different protein fractions and reduce the overall amount of purchased protein and increase income over feed cost.

In addition to balancing for metabolizable protein, rather than crude protein, nutritionists can often drive milk protein content and yield by balancing both the methionine and lysine components of the ration. Methionine and lysine have long been known to be first-limiting amino acids for production of milk and milk protein by dairy cattle, and supplementation with various sources of methionine to include both rumen-protected forms and analogs have been shown to increase yields of milk protein.

Lysine typically is high in commercially available forms of soy that have been processed to increase their rumen undegradability and other protein sources such as blood meal and various protein blends that are available commercially. Researchers at Ohio State and Cornell have illustrated that the digestibility of these animal protein sources can vary and an assay developed at Cornell by Dr. Mike Van Amburgh's group is being deployed currently at various commercial feed analysis laboratories to enable feed suppliers to evaluate the digestibility of their protein sources.

Energy supply appears to also be important for responses to metabolizable protein and amino acids. Protein synthesis depends upon energy supply and we believe that rations with higher overall carbohydrate fermentability will give better overall responses when combined with balancing approaches for metabolizable protein and amino acids.

Figure 3. "Milk component prices"



Milk fat and milk protein prices (\$/lb) based upon Federal Milk Marketing Order data from 2008 to 2015.

Identifying the economic opportunity

When we work with farms to evaluate the opportunities for improved components, determination of potential return on investment requires consideration of the potential response, potential for increased milk revenue based upon milk component prices, and likely increased investment on the nutritional side (replacement of lower quality, cheaper feeds with higher value but higher cost feeds, inclusion of amino acids, and inclusion of certain feed additives).

We see in Figure 3 that milk protein values typically exceed the value for milk fat. However, there are times, such as parts of 2010, 2011, and 2014, when the value for milk fat is comparable to that of milk protein. It is relatively straightforward to calculate an estimated value for increased yields of milk fat or protein and identify the potential investment required on a feed standpoint.

In both the cases of milk fat and milk protein, nutritional interventions generally yield positive responses within 10 to 14 days. If the herd does not respond during that timeframe, the nutritional strategy that was chosen likely was not limiting for production of milk fat or milk protein. □

Dr. Thomas Overton (tro2@cornell.edu) is Professor of Dairy Management at Cornell University and **David Balbian** (drb23@cornell.edu) is Dairy Specialist with the Central New York Dairy and Field Crops program of Cornell Cooperative Extension.